Turkish Economic Review
www.kspjournals.org
Volume 5 March 2018 Issue 1

The analysis of bubbles and crashes on financial markets for emerging economies: Evidenced From BRICS

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Abstract. The study was conducted to analyze the bubbles, and crashes on the financial market in emerging economies; (BRICS) stock prices were employed to detect the existence of the bursting bubble. The Right-tailed Augment Dickey-Fuller Unit Root Test used to complete the study of analyzing bubbles and crashes. The study consists of four primary tests; ADF, RADF, SADF, and GSADF Moreover, the study used the first three criteria. The survey covered the period from 2000 to 2016, to absorb the nuclear currently financial crisis in the BRICS and analyze its impacts. Also, this period coincides with both economic reforms in some countries like China and early indications of an impending US crisis. The findings in all countries rejected the null hypothesis of no bursting bubbles in the stock market in favor of the alternative theory. The findings suggest that such an explosive behavior may be attributable to differences in stock prices of traded goods. The result has economic policy importance and implications on the economy.
Keywords. BRICS, Emerging economies, Financial bubble and crashes, Right-tailed ADF, Stock price.
JEL. F60, G70, O15.

1. Introduction

In a recent and past decade, we have witnessed different periods of price fluctuation in financial markets. This variation affects global economy directly and causes another impact on the society living in the countries where this price fluctuation happened. These changes have been paid attention, and these attentions had been growing up in the same world, there have been different moments in the financial market that happen unexpectedly and cause a sudden panic to the people and crashes of the financial markets, people lose their investments plus other forms of funds. Suitable examples of some accidents include that of 2008 financial crisis that affected the whole world.

Different scholars have defined a "*financial bubble*," but in this paper, we refer to a definition established by Kindleberger, (1991) is an increase in stock price motion over extended periods that after a specific pace and unexpectedly implodes. Financial bubbles show the appreciations in asset price that are eventually unjustifiable and instability due to high irrational concentrations of capital. The result of further expansions leads to a crash. So crash occurs after a bubble.

A "stock market bubble" is another type of economic bubble that takes place in stock markets when dealers and investors drive stock prices beyond their intrinsic value about some system of stock valuation. A "stock market crash" this is an unexpected decline of market asset prices across a stock market that results in a significant loss of value, several reasons drive crashes included panic as much as

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by underlying economic factor. Accidents always follow speculative stock market bubble.

When the trading prices of the asset are dramatically rising above the face value, this is what we call a bubble. There have been some historical examples of bubbles as described in different kinds of literature, for instance, Garber (2000) include the following: The oldest one, The Dutch Tulip Mania of 1634 to 1637, The Mississippi Bubble of 1719 to 1720. The South Sea Bubble of 1720 which was the significant outcome of a scam, the bubble which ended up being famous with black Monday. Recently we have witnessed other bubbles including IT bubble of 1997 to 2000 and the other one which trended all over the world the Subprime Crisis in 2008.

After the bubble and crash of financial markets of 2008, bubbles spread over different financial instruments including the following stocks, real estate, credit risk, and commodities. Caballero *et al.,* (2008) argued that most of the recent happening bubbles are closely related, then Phillips & Yu (2011) have later supported the views of Caballero *et al.,* (2008) by making an analysis on econometric bubble tests and a unique experiment on the migration of bubbles between asset categories. Their trial based only on past information as the result they used data of only 1990's, findings are interesting for further expansion of the dataset.

BRICS is an acronym for an association of five countries, namely, Brazil, Russia, India, China and South Africa. It's a new block in the global economy formed as the consideration of deceleration to the well-developed savings regarding growth and economics enlargement. BRICS are also considered as the more widespread acceptance and excellent transformation block as the emerging superpower in the world. BRIC was formed in 2001 as Brazil, Russia, India, and China; later South Africa showed her full interest to join the block. In 2010 South Africa was introduced as a full member of this new super leading neighborhood in the world BRICS.

As per the report of 2015, the five BRICS countries represent half of the world's population that is over 3.6 billion. Their community mentions all of the members of BRICS in top 25 of the world, and four of them are in top 10. BRICS combined its nominal GDP of US$16.6 trillion, which is equivalent to 22% of the world gross world product, also approximated to GDP (PPP) of US$37 trillion, and US$4 trillion combined foreign reserves. Source: World Economic Outlook (2013).

All five countries in the BRICS each nation is well known for its distinctiveness and ability. Brazil is well known and famous for a well-developed economics structure, Russia is a well-known country for the commodity-driven economy, India is a base of the domestic demand-driven economy, China as a powerhouse of exports, and South Africa as the primary representative of the fast-growing region in Africa. Growth is the principal tool for this community that makes BRICS a powerful and contribute large percent to the global economy and enhance comprehensive economic policy and financial stability.

The work is organized as follows; the first section consists of the introduction of the study and BRICS. The next part is explaining the literature review used as the guideline of the study. The third section is talking about the research methodologies and data sources. The fourth section includes the findings and discussion of the study while the last part highlights conclusion, recommendation, further study, and references.

2. Literature review

The first trial to study bubbles and crashes in financial markets was done by Sornette *et al.,* (2001, 2003). They introduced an explicit functional form to identify bubbles and crashes by stressing more importance on the end of the bubbles as a natural distinctiveness because its occurrence is at a particular analytical time. According to the method of bubbles and crashes detection, bubbles

can be predicted at the end of it practically. On the other hand, they couldn't explain anything about the start stage of the bubbles.

Kaizoji (2005, 2006) and Sornette *et al.,* (1996, 2006, 2008) contemplated their study with positive feedback that was taken as the primary cause for the foundation of speculative bubbles, and a long-period power law well measures these. Sornette (2003) on his study about bubbles and crashes, argued that all bubbles that lead to a crash can certainly be analyzed by a log-periodic power law to forecast when a financial stock market will get into a crash, consider the envelope of the Deutsche Aktien Index (DAX). Ausloos & Ivanova (2001, 2002) they demonstrated a conclusion that before crashes, a long-period pattern exists.

Johansen & Sornette (2010), found out that endogenous financial crashes are preceded by a log-periodic power law (LPPL) and concluded that crashes that are not headed by an LPPL are exogenous and caused by a robust external burst of volatility. Sornette *et al.,* (2004, 2009 and 2010) applied the same model of the LPPL and revealed a similar finding. Also, it is essential mentioning Sornette *et al.,* (2012) used pattern recognition method researched the diagnosis and prediction of market rebounds on financial markets to predict its rebounds.

Overconfidence leads agents to overstate the accuracy of noisy signals and hence over-react to the signal. On the other hand, when agents over-react to various signs, they end up with significantly distinctive beliefs. Kyle & Wang (1997), Odean (1998), and Scheinkman & Xiong (2003) examined models with heterogeneous views invented from agents' overconfidence. They used a different model that produced a finding that highlighted heterogeneous aspects can mainly cause extreme trading and asset price bubbles in the financial markets.

Brunnermeier (2001) posited that liquidity and free trading elevate share prices in an economy with high liquidity and low-interest rates. Such a situation could develop a bubble. Theoretically, a bubble is said to occur if an increase in prices consistently exceeds 50% within a given period preceding the bubble crash. In such a situation, stock market prices are usually overvalued.

Janszen (2008). Described a bubble as the huge spike in asset prices that result that depraved from a self-reinforcing notion system, a fog that clouds the judgment on all, but the most aware participants in the market. He added that the bubble is the result of that financial madness, seen only when the fog rolls away. Thus, those who are reaping the temporary benefits of the bubble would rarely abandon the folly until it is all over (a crash).

Friedman & Abraham (2006), posited that bubbles and crashes manifest occurrence of extended models which incorporate endogenous market risk premium that is based on investors' historical losses and constant gain learning and that when losses have been small for a long time, asset prices inflate as portfolio managers continue to add riskier portfolios. They said that close to the point of saturation, slight losses could trigger a crash due to widening risk premium acceleration and decline in the asset price. They concluded that bubbles do not often repeat as well as a crash as people became cautious and slow to the reaction if similar episodes were to occur. According to Kindleberger (1991), 'high prices that do not crash are not regarded as a bubble.' A significant characteristic of the bubble, therefore, is a crash. Other occurrences are minor depressions.

Abreu & Brunnermeier (2003), found that rational agents are aware that bubbles are always there, but this is considered as the difference in opinions that rely on timing when the bubbles start. Rational arbitrageurs drive the bubble up to a point where it can synchronize, and this is due to a piece of exogenous information. This model provides a better and persuasive argument in contradiction to Efficient Market Hypothesis assertions that even if there are irrational agents in the market, rational arbitrageurs will block any opportunity of mispricing.

Lin & Sornette (2011), presented their argument that it is just a difference in opinions which based on the timing at the end of the bubbles that may lead to the persistence of bubbles. Finally, they agreed with their assertion by employing their

model on real data and developed an operational technique that allows them to diagnose bubbles and estimate their termination.

Shiller (2002) shows a couple of numbers of behavioral mechanisms to be at the beginning of bubbles. And there are some which are relevant to a positive way as feedback loops between the prices and investor's enthusiasm and herding; the fact is that people tend to mimic each other.

Lux (1995) designed a framework of two kinds of agent namely: speculative traders and fundamentalist. Speculative traders establish their business decision based on others but of the same type as well as on price fluctuation (dynamics). While fundamentalists form their business decision based on the difference between asset's market and the fundamental values. The relation between the Ising-like speculative traders and fundamentalists influences the rise to a rich phenomenology of price dynamics, and prices moving about and symmetry as well as boom and crash phase, basing on the range of parameters. This portrays that to some extent simple mechanisms are enough to establish a variety of dynamical regimes.

Miles, (2002) many of the developing countries started to show up changes in the stock market through the financial market system reforms and liberalization that caused some new questions on the relationship between stock market volatility and liberalization. Findings show that there have been some researchers conducted and their results are used as evidence to some of the observed financial crises in emerging markets including Russia, Asia, and Mexico. For the economic reforms that have taken place in emerging markets including Nigeria need thorough research to analyze the impacts of financial crises on financial stock markets and financial sector in general.

3. Data sources and research methodology

The financial dataset for this study is sourced from Yahoo Finance and Investing.com. The dataset covers the period from 2001 to 2016 that makes 15 full years, and the study coverage begins from 2001 to detect and analyze the global financial crisis in the financial stock market for the whole period. Stock closing price is the primary variable used in the study from the following indices while extracting dataset, Brazil (Ibovespa-BVSP-Sao Paul Stock Exchange), Russia (Mosco Stock Exchange-MICEX), India (Bombay Stock Exchange-BSE), China (Shanghai Stock Exchange-SSE) and South Africa (Johannesburg Stock Exchange-JSE).

Data transformation is referred as the process of altering data's origination to a format that is more appropriate to run a data analysis (Zikmund's, 1997). To change data format we used the formula below: Data format changing done on Eviews 9.5.

$$Series\ (rx) = log(x) - log(x(-1))$$

3.1. Data analysis

Augment Dickey-Fuller Unit Root Test (ADF)

An ADF test was developed to tackle the problem of autocorrelation in the dataset; ADF test is done to check the stationary of the dataset before running any test. ADF has three main equations:

$$\Delta Yt = B1 + ZY_{t-1} + a_i + e_t \quad (1)$$

$$\Delta Yt = B1 + B2_t + ZY_{t-1} + a_i + e_t \quad (2)$$

$$\Delta Yt = ZY_{t-1} + a_i + e_t \quad (3)$$

Whereas ΔYt represent the variable: example closing stock price, B_1 is the intercept (Constant), $B2_t$ is the trend of the variable, and e_t is the error term (stochastic error term): Hypothesis;

H_0 Variable has unit root
H_1 Variable is stationary (No unit root test)

3.2. Testing for bubbles and crashes

There are some models developed on bubbles detection strategies and were presented by Phillips, Wu, & Yu (2011, PWY) and Phillips, Shi, & Yu (2013, PSY). These models are fundamentally based on recursive and rolling ADF unit root tests which empowered us to detect bubbles in the dataset. This kind of tests is attached to the Rtadf file in the EVIEWS-Add in under a right tail variation on the Augment Dickey-Fuller unit root test whereby the null hypothesis is of a unit root, and an alternative is of a mildly explosive process.

Rtadf, an EViews Add-in that allows end-users to quickly test for the existence of bubbles in the data by readily applying four variations on the right tail ADF unit root test. Four tests include the standard ADF test and a rolling window ADF test, and the more recent PWY supremum ADF (SADF) test and the PSY generalized SADF (GSADF) test. The add-in capabilities include calculations of the relevant test statistic and the derivation of its corresponding critical values by Monte Carlo simulations.

There are four test strategies implemented by Rtadf add-in to detect bubbles in the market, which include the ones proposed by PWY and PSY. These are all based on the difference between reduced-form empirical equations:

$$Yt = \mu + \delta Y_{t-1} + \sum_{i=1}^{\rho} \phi_i \, \Delta Y_{t-i} + \varepsilon_t. \qquad (4)$$

Whereby $Ytis$ referred as the variable in the equation (The Stock Price), μ is an intercept; ρ is referred as the maximum number of lags, $\pi_i \; for \; i = 1 \; and \; \rho$ are referred to as the differenced lags coefficients, and ε_t is denoted as the error term.

The second type of test, the rolling ADF (RADF) test, is a rolling version of the first test in which the ADF statistic is calculated over a rolling window of the fixed size specified by the user, i.e., $r_w = r_0$ for all estimations. At each step of the RADF procedure, the window's start and end point ($r1$ and $r2$ respectively) are increment one observation at a time.

The third type of test is SADF test, suggested by PWY, is based on recursive calculations of the ADF statistics with a fixed starting point and an expanding window, where the user sets the initial size of the window.

Note that: in the last step, the estimation will be based on the whole sample (i.e., $r_2 = 1$ and the statistic will be ADF_1). The SADF statistic is defined as the supremumvalue of the ADF_{r2} sequence for $r_2 \in [r_0; 1]$:

$$SADF(r_0) = \sup_{r_2 \in (r_0; 1)} (ADF_{r2})$$

The fourth and last test is the generalized SADF (GSADF), suggested by PSY. This test generalizes the SADF test by allowing more flexible estimation windows, wherein, unlike the SADF procedure, the starting point, r_1, is also allowed to vary within the range$[0, r_2 - r_0]$. Formally, the GSADF statistic is defined as:

$$GSADF(r_0) = \sup_{r_2 \in \{r_0, 1\}.} \left(ADF_{r_1}^{r_2} \right).$$

$$r_2 \in \{0, r_2 - r_0\}.$$

Table 1. *Augmented Dickey-Fuller Unit Root Test*

	Brazil	Russia	India	China	South Africa
Order I (0)	-1.387	-1.283	-0.439	-1.891	-0.613
	(0.590)	*(0.639)*	*(0.900)*	*(0.337)*	*(0.865)*
I (1)	-64.059	-61.351	-45.909	-63.639	-61.607
	(0.0001)	*(0.0001)*	*(0.0001)*	*(0.0001)*	*(0.0001)*

To test for non-stationarity of the variable, standard ADF test was conducted.

As the tests are presented, it shows that series was not stationary at level and we cannot reject the null hypothesis in favor of an alternative, hence integrated to first order that showed stationary of the series as presented in table 1 above.

Table 2. *Summarized Descriptive Statistics.*

	Brazil	China	India	Russia	S. Africa
Mean	0.000217	0.000246	0.000383	-0.000644	0.000405
Median	0.000503	0.000273	0.000972	-0.000114	0.000791
Maximum	0.136766	0.094008	0.159900	0.206571	0.077088
Minimum	-0.120961	-0.092562	-0.118092	-0252261	-0.079585
Std, Dev	0,018283	0,016216	0,015545	0,020504	0,013364
Skewness	-0,061992	-0,275856	-0,193946	0,249333	-0,076847
Kurtosis	6,65549	7,571515	9,91608	20,3673	6,170924
Jarque-Bera	2209,596	3502,051	7925,131	49859,15	1664,612
Probability	0,000000	0,000000	0,000000	0,000000	0,000000
Observation	3964	3964	3964	3964	3964

Kurtosis (Kurt): Kurtosis depicts the flatness of the data distribution. The kurtosis for the study is above the standard of 3 that is statistically known as Leptokurtic, which means that data distribution is positive kurtosis and there is a standard distribution. This supports that many values are closer to mean average of each stock market.

In the financial market, kurtosis is interpreted as the most critical area that helps to study risks and returns on the investment. According to stock traders and analysts leptokurtic means that risks are generated from outlier events, this would be a type of stock which is enormous for those investors that are risk takers while a stock market with less value of kurtosis is considered to be more safer of investors to invest and buy more securities. All value for kurtosis is above the standard gauge that depicts that financial market is not safe for investment as shown in table 2.

Standard Deviation (Sd): SD is interpreted as mean average, as it is there to define as the amount of risk. In economics and finance, SD helps to determine the number of risks investors would take when purchasing specific security. So, SD in finance is named as volatility to gauge the risks. Massive fluctuations tell investors how much fund is deviated from an expected return as stipulated in table 2.

Skewness (Skew): A positive skewness is an intuitively thought of a dataset distribution of a significant right tail probability of extremely high gains to an investor. In contrast, a negative skewness goes with a massive left tail with a high possibility of loss to investors. Only Russia showed a positive skewness of 0.249 that depicts that is the only market that is safer from an investor to the investor while rest of the markets is with negative results, Brazil -0.062, China -0.276, India -0.194 and South Africa -0.077.

4. Empirical findings

The study applied the right-tailed unit root test that is found in the Eviews-Add-in. The results are from the following tests ADF, RADF, and SADF.

Table 3. *Brazilian Stock Market Test*

Test	T-Statistic	Critical Value		
		99%	95%	90%
ADF	-13.279	0.625	-0.07	-0.43
RADF	-10.096	0.625	0.07	-0.43
SADF	-12.278	2.219	1.58	1.35

Note: Critical values are calculated from Monte Carlo simulation with 1000 replication, r_0 (Initial Window), the maximum observations were selected automatically.

Standard ADF T-statistic values and the corresponding critical values are all absolute numbers, as the value of standard ADF T-statistic lies above the consequent critical value this provides evidence and proof of explosive bubble existence in the Brazilian stock market. The Standard ADF T-statistic is -13.279 that is significant to all confidence level as at 99%, 95%, and 10%. The RADF Test figure 1, below shows a better understanding of the bursting bubbles and crashes in the Brazilian stock market, as at the beginning it shows a collapse while in 2007 to 2008 period depicts the bubbles which might be the spillover from the USA subprime crisis that spread all over the world. Furthermore, the SADF test graph shows that the collapsing had started from 2000 period up to 2008 when it came to its maximum, and then the turned to normal under the confidence level of 10%.

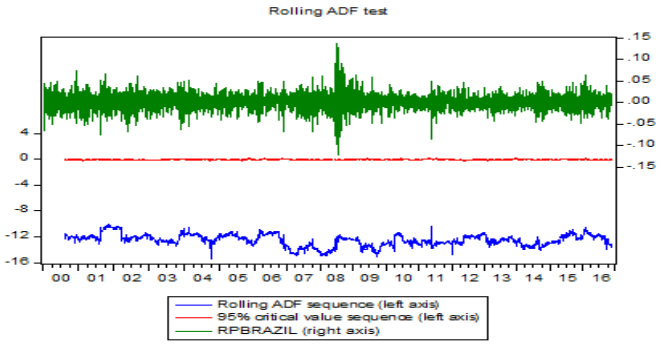

Figure 1. *Rolling ADF Test*

Table 4. *China Stock Market Test*

Test	T-Statistic	Critical Value		
		99%	95%	90%
ADF	-13.592	0.625	-0.07	-0.43
RADF	-9.783	0.625	0.07	-0.43
SADF	-7.418	2.157	1.62	1.38

The results were obtained from Eviews-add-ins, critical values generated from Monte carol with replication of 1000, r_0 (Initial Window) 159, sample size 4233.

China's stock market has gone through a various financial crisis, and the tests run to detect the bubble and crash depicted that null hypothesis of no explosive bubble must be rejected in favor of the alternative theory of the dataset have bubble explosive. Standard ADF T-statistic value lies above the corresponding critical values that are obtained from the simulation as shown in table 4 and the figures are absolute. RADF test results join the standard T-statistic to confirm the existence of bubbles and crash in the SSE financial stock market. The figure 2 shows how the data onto the financial market behaves, as at the beginning there is a collapse and a giant bubble during 2007-2008 that is believed to be caused by the subprime crisis periods. Figure 2 provides further details of the collapsing and bubbles with the beginning of 2007, SADF test narrates much more about the existence of the bursting bubbles in the SSE stock market at all confidence levels.

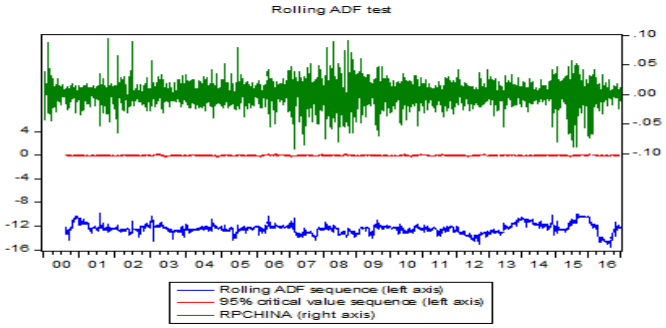

Figure 2. *Rolling ADF Test*

Table 5. *Indian Stock Market Test*:

Test	T-Statistic	Critical Value		
		99%	95%	90%
ADF	-12.996	0.625	-0.07	-0.43
RADF	0.662	0.624	-0.07	-0.43
SADF	-7.608	2.002	1.52	1.29

The results were obtained from Eviews-add-ins, critical values generated from Monte carol with replication of 1000, r_0 (Initial Window) 159, sample size 4233.

The Standard ADF test on table 5 shows that there is a high possibility of the existence of bubbles and crashes in the data; the hypothesis of no explosive bubble is rejected in favor of mildly explosive bubbles in the data that is alternative hypothesis. SADF test to provide a better understanding of the detection of the bubble. This tiny bubble might be from the spillover of the 1997 to 2000 dot-com bubble. During this period the impact on technology industry affected the entire world even the Indian stock market showed the signs of hyperactivity.

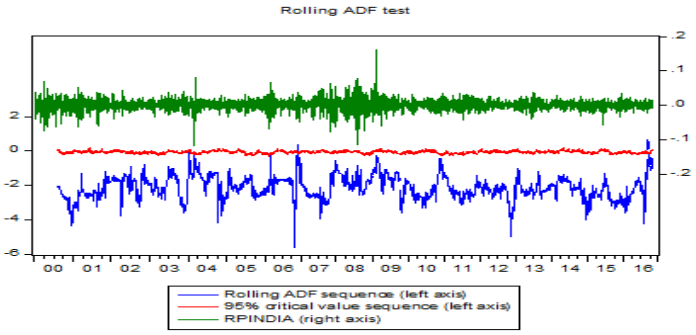

Figure 3. *Rolling ADF Test*

Figure 3 above shows the existence of bubbles in the data onto the period tested, under sequence critical value at 95% the hypothesis of there is no explosive bubble is rejected in favor of the alternative theory that is there is the bubble in the Indian Stock Market. The graph shows multiple bubbles that occurred at the beginning of 2004; the second occurred between 2006 and 2007 while the last bubble occurred in 2016.

Table 6. *Russian Stock Market Test:*

Test	T-Statistic	Critical Value		
		99%	95%	90%
ADF	-9.462	0.625	-0.07	-0.43
RADF	-9.901	0.632	-0.06	-0.43
SADF	-4.225	2.282	1.65	1.33

The results were obtained from Eviews-add-ins, critical values generated from Monte carol with replication of 1000, r_0 (Initial Window) 159, sample size 4233.

The Russian stock market suffered from the explosive bubble as the results from the test depict the existence of bubbles in the data. The standard ADF test results (T-statistic value is above the critical values) this applies as the evidence for the life of bubbles. Same to RADF and SADF tests results that show the existence of bubbles in the financial stock market of Russia at all levels of significance.

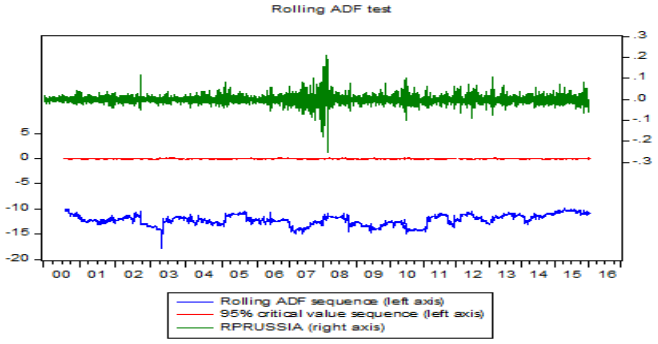

Figure 4. *Rolling ADF Test*

Figure 4 above does not provide direct evidence for the existence of bubbles in the data. So, having an argument based on the graph there is not enough evidence of the critical values provides evidence for the existence of bubbles in the Russian Stock Market.

Table 7. *South African Stock Market Test*

Test	T-Statistic	Critical Value		
		99%	95%	90%
ADF	-25.097	0.625	-0.07	-0.43
RADF	-61.607	0.631	-0.06	-0.42
SADF	-2.983	2.224	1.65	1.33

The results were obtained from Eviews-add-ins, critical values generated from Monte carol with replication of 1000, r_0 (Initial Window) 159, sample size 4233

Standard ADF test, a result rejected the hypothesis that the data has no explosive bubble in favor of the existence of bubbles. The Standard ADF t-statistic is above the critical value at all levels of significance of the test were done under 95%. Only this analysis won't justify the finding as for the result the RADF forward test was tested, the RADF test depicted out that there is an existence of bubbles in the market since the RADF t-statistic value is also above the critical values that were generated from Monte Carlo simulation. Furthermore, SADF test was conducted to find out the justification for the dataset from 2000 throughout 2016, the result from the analysis showed that there is a high possibility of bubble existence for the selected period.

The Rolling ADF graph below clearly explains the behavior of the data from 2000 throughout 2016. The market started collapsing end of 2000, after that, the graph shows a bubble from 2005 to 2006 which is believed to be from the influx of investors behavior into South African assets on equities that raised up its price. Also, it shows a bubble in 2009 as the spillover from the subprime that affected almost the world's financial market.

On the other side, SADF graph openly depicts the bubble from the end of 2005 to 2007 that marks the beginning of the subprime crisis, so in general, this might be as a result from the global financial crisis. This finding aligns with Elike & Anoruo, (2017). In their conclusion, they showed that there is evidence of explosive bubble behavior in the South African Stock Market with the first being occurred between in October 1984 and March 1985. Another there was a bubble that started in 2001 and crushed in 2003.

5. Conclusion

This study has examined the existence of speculative bubbles and crashes in the financial market for the emerging economies (BRICS) for the period running from period 2000 through 2016. Specifically, the study used the subsequent unit root tests including the right-tailed ADF tests, the SADF, and RADF test to investigate the existence of speculative bubbles and crashes in the BRICS. These techniques have been specially designed to provide an early warning system for periodically

collapsing bubbles (Evans, 1991). The results from the standard right-sided ADF test failed to reject the null hypothesis of no explosiveness in stock prices. Results from the standard right-sided ADF procedure may be misleading, particularly in the presence of periodically collapsing bubbles. The results from the RADF and SADF test failed to reject the null hypothesis of non-speculative bubbles in stock price.

Graphical results show evidence of speculative bubbles. The first bubble saw in Indian stock market from 2006 and 2016. China stock market has been experiencing ups and down as the spillover effects from the European market and the USA's stock market fluctuations, in 2015 throughout 2016 as the current bubble. The South African stock market first bubble started October 2000 and ended in December 2000. This particular bubble was brief and lasted for a total of two months. The third bubble lasted for about two years (24 months). It started in January of 2001 and ended in January 2003. Taken together, the results from the SADF and RADF tests to suggest that the explosive behavior in stock markets can be attributed to movements of traded stock price. Brazil and Russia experienced bubbles during the global financial crisis from 2007 though out 2009 confirmed via graphical results from RADF.

The results from this study highlight the critical roles the essential fundamentals play in determining explosive bubbles in asset prices. The investors should be cognizant of the existence of bubbles in stock prices. This knowledge will enable them to identify early warning signs of a speculative bubble. It will also allow them to be flexible and wise to sell their assets and, hence, adjusting the share prices toward their fair values leading to the attainment of market efficiency. Further study should include GSADF that will help to detect the exact date when bubble and crash happened in stock price data. The dividend would add the value of the study if included in the model. Furthermore, global exchange rate, global stock markets, the bitcoin and other crypto-currency markets, offer compelling empirical applications for the types of models considered in this study.

References

Abreu, D., & Brunnermeier, M.K. (2003). Bubbles and crashes. *Econometrica*, 71(1), 173-204. doi. 10.1111/1468-0262.00393

Ausloos, M., & Ivanova, K. (May 01, 2002). Mechanistic approach to generalized technical analysis of share prices and stock market indices. *The European Physical Journal B - Condensed Matter and Complex Systems*, 27(2), 177-187. doi. 10.1140/epjb/e20020144

Brunnermeier, M.K. (2001). *Asset Pricing Under Asymmetric Information: Bubbles, Crashes, Technical Analysis, and Herding*. Oxford University Press.

Elike, U., & Anoruo, E. (2017). Testing for explosive bubbles in the South African-US exchange rate using the sequential ADF procedures. *Banks and Bank Systems*, 12(1), 105-112. doi. 10.21511/bbs.12(1-1).2017.02

Evans, G.W. (1991). Pitfalls in testing for explosive bubbles in asset prices. *The American Economic Review*, 81(4), 922-930.

Friedman, M., Savage, L.J., & Becker, G.S. (2007). *Milton Friedman on Economics: Selected Papers*. Chicago: University of Chicago Press.

Garber, P.M. (2000). *Famous First Bubbles: The Fundamentals of Early Manias*. MIT Press, Cambridge, MA.

IMF, (2013). World Economic Outlook. [Retrieved from].

Janszen, E. (2008). The next bubble: Priming the markets for tomorrow's big crash. Harper's, 39-45.

Johansen, A., & Sornette, D. (2001). Finite-time singularity in the dynamics of the world population, economic and financial indices. *Physica A*, 294(3-4), 465-502. doi. 10.1016/S0378-4371(01)00105-4

Johansen, A., & Sornette, D. (2010). Shocks, crashes and bubbles in financial markets. *Brussels Economic Review*, 53(2), 201-253.

Kaizoji, T. (2005). Statistical properties of absolute log-returns and a stochastic model of stock markets with heterogeneous agents. *Nonlinear Dynamics and Heterogeneous Interacting Agents*, 550, 237-248. doi. 10.1007/3-540-27296-8_16

Kaizoji, T. (2006). A precursor of market crashes: Empirical laws of Japan's Internet bubble. *The European Physical Journal B*, 50(1), 123-127. doi. 10.1140/epjb/e2006-00142-9

Kyle, A.S., & Wang, F.A. (1997). Speculation duopoly with agreement to disagree: Can overconfidence survive the market test?, *Journal of Finance*, 52(5), 2073-2090. doi. 10.1111/j.1540-6261.1997.tb02751.x

Lux, T. (1995). Time variation of second moments from a noise trader/infection model. Bamberg: Ott-Friedrich-Univ., Fak. Sozial- und Wirtschaftswiss.

Phillips, P.C.B., Shi, S., & Yu, J. (2015). Testing for multiple bubbles: Limit theory of real-time detectors. *International Economic Review*, 56(4), 1079-1134. doi. 10.1111/iere.12131

Phillips, P.C.B., Wu, Y., & Yu, J. (2011a). Explosive behavior in the 1990s nasdaq: When did exuberance escalate asset values?, *International Economics Review*, 52(1), 201-226. doi. 10.1111/j.1468-2354.2010.00625.x

Phillips, P.C.B., & Yu, J. (2011). Dating the timeline of financial bubbles during the subprime crisis. *Quantitative Economics*, 2(3), 455-491. doi. 10.3982/QE82

Rayan, K. (2008). *Financial Leverage and Firm Value*. Johannesburg: GIBS.

Scheinkman, J.A., & Xiong, W. (2003). Overconfidence and speculative bubbles. *Journal of Political Economy*, 111(6), 1183-1219. doi. 10.1086/378531

Shiller, R.J. (1999). Measuring bubble expectations and investor confidence. *NBER Working Paper*, No.7008. doi. 10.3386/w7008

Shiller, R.J. (2003). From efficient market theory to behavioral finance. *Journal of Economic Perspectives*, 17(1), 80-104.

Sornette, D. (2003). *Why Stock Markets Crash: Critical Events in Complex Financial Systems*. Princeton, N.J: Princeton University Press.

Sornette, D. (2003). Critical market crashes. *Physics Reports*, 378(1), 1-98. doi. 10.1016/S0370-1573(02)00634-8

Zikmund, W.G. (1997). *Exploring Marketing Research*. Fort Worth, TX: Dryden Press.